**Sustainable intensification indicators framework**

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**1. What is Sustainable Intensification?**

Sustainable Intensification focuses on improving the efficient use of resources for agriculture, with an emphasis on how to produce more food on the same amount of land.  The term "sustainable intensification" originated in the 1990s in the context of how to achieve improved yields over the long-term in fragile environments of Africa (Pretty, 1997; Reardon et al., 1995).  This has the potential to reduce pressure from population growth on the conversion of natural lands to agriculture (Cook et al., 2015).  Unfortunately, sustainable intensification has become a buzzword that is often used to describe any type of agricultural intensification that may have some potential environmental benefit (Godfray, 2015).

Research on sustainable intensification (SI) needs to be interdisciplinary, drawing upon the theories and methods of the biophysical and social sciences. Recent SI work has a major emphasis on crop management strategies that can reverse land degradation and reduce yield variability despite climatic changes (Dahlin and Rusinamhodzi, 2014). Much of this SI research focuses on environmental aspects of sustainability using biological and ecological principles to improve the ecosystem services of the farming system and reduce the environmental problems associated with it (Petersen and Snapp, 2015).

However, environmentally sound and economically profitable production practices may ignore the complex social dimensions of sustainability. SI is often presented as a solution to food insecurity and malnutrition and therefore must consider the distribution of benefits from improved production, with more attention given to equity, poverty alleviation and gender empowerment (Loos et al., 2014). Ignoring these aspects can threaten the sustainability of enhanced production. For example, food insecurity can cause farmers to sell off productive assets to meet their basic needs and thus return to a lower productivity level. Even if one defines agricultural sustainability without these social elements there is widespread agreement on the desirability of working towards their improvement, and responsible agricultural development should seek to enhance and not hinder these social goals.

**2. The Sustainable Intensification Indicator Framework**

*a. Purpose of the SI indicator framework*

The sustainable intensification indicators framework aims at providing a synthesized list of sustainable agricultural intensification (SI) indicators and metrics, categorized into five domains (productivity, economic, environmental, social and human condition) and three scales (field farm/households, and landscape). The framework is mainly intended for use by agricultural scientists working in research for development projects but is flexible and can be used by scientists interested in sustainable intensification more broadly. It is not intended to fit all requirements or replace other efforts to develop SI indicators, but rather to provide a common framework that can guide research on SI and facilitate cross-program learning and assessment on the factors that lead to increasing sustainability.

The framework is developed to provide a knowledge base on indicators and metrics. We intend the framework to include both ‘gold standard’ approaches to assessing SI, and simplified metrics as options that are feasible to use while accounting for spatial, temporal and cost limitations. In addition to methods for measuring SI indicators, the framework presents several approaches for analyzing SI interventions (technologies, management practices, policies) within the context of broader farming and livelihood systems. For example, researchers can carry out a thought experiment exercise to consider in a systematic way how the various indicators listed under each domain might be affected positively or negatively by an intervention that they are investigating or planning to research. This qualitative assessment should be informed by the scientific literature as well as by discussions with farmers, fellow researchers, NGOs or other stakeholders about the potential direct and indirect effects of a SI intervention. This would help researchers be better able to detect synergies and tradeoffs and minimize unintended negative consequences by mitigating them through the research design.

A more robust use of the SI indicator framework is to quantify relative sustainability by comparing indicators from several domains across time and/or space. SI indicator metrics can be presented through visualization techniques such as radar charts to compare performance of innovations or interventions, or for a range of environmental contexts where an intervention has been implemented and also between “treatment” and “non-treatment” groups. For the latter objective, to compare technology performance within intervention and non-intervention communities, then this should be done in the same time period across plots, households or communities that are as similar as possible and comparisons over time will need to consider what else has changed in that time period (policies, rainfall, prices, etc.).

The results can be analyzed and presented so that the performance of an intervention can be easily compared to the status quo for the most relevant indicators for each intervention across all five domains. The goal is to provide research results that communities, scientists, implementation partners and policy makers can objectively evaluate with explicit linkages across potentially competing sustainability goals (e.g. biodiversity conservation, agricultural production, food security, and gender equity). When research on agricultural technologies is conducted with a small number of farmers, a number of assumptions will need to be made when considering the potential impact of widespread use of the technology. Various types of qualitative research and modeling may be useful for this purpose. This quantitative use of the framework can be complementary to adoption studies by considering the performance of the technology holistically, though adoption studies consider other questions as well.

It is worth mentioning that the SI indicators framework could also be used to guide monitoring and evaluation efforts in development projects. All of the key concepts and how to measure them are presented in the current efforts to develop this framework. However, it is not possible in our timeframe to develop the algorithms that would be necessary to effectively aggregate plot and household level indicators to a larger scale of analysis so that the project-level effect can be estimated (such as at the village, watershed or sub-district level). Nevertheless, the same process for choosing the most relevant indicators and reflecting on synergies and tradeoffs could be applied to M&E for development projects.

*b. Five domains of Sustainable Intensification*

To facilitate the organization of the various dimensions of sustainability, the indicators of sustainable intensification have been classified into five domains: productivity, economic, environment, human condition and social. Categorizing the dimensions of sustainability into these domains is based on defining the particular domains through discussion with scientists. The assignment and choice of domains may have some level of ambiguity as some indicators may have characteristics of other domain definitions. For our purpose we have described and organized the domains as follows:

Productivity: This domain focuses on productivity of the land as a key concern in the context of growing populations, land degradation and threatened biodiversity from loss of natural habitat. Intensification focuses on increasing the productivity of any input (such as labor) but we leave those for the economic domain as they tend to be of secondary importance in the debates on sustainable intensification.

Economic: This domain focuses on issues directly related to the profitability of agricultural activities. In addition to profitability itself this domain includes indicators related to the productivity of inputs other than land (water, fertilizer, labor, capital) as well as indicators likely to affect the probability of investment in enhancing productivity (market participation). Finally, poverty rates are included in this domain as they can be directly affected by increased profitability. Poverty could otherwise be included in the human condition domain.

Environment: This domain focuses on the natural resource base for agriculture (soil, water), the environmental services directly affected by agricultural practices (habitat) and the level of pollution coming from agriculture (pesticides, greenhouse gases).

Human condition: This domain contains indicators that pertain largely to the individual, such as their nutrition status, food security, and capacity to learn and adapt. These concepts are certainly dependent on social interactions but are distinct from those in the social domain which directly focus on inter-personal relationships.

Social: This domain focuses on social interactions: equitable relationships across gender within the household, equitable relationships across social groups in a community or landscape, the level of collective action and the ability to resolve conflicts.

*c. Scales of analysis*

Measuring sustainable intensification typically requires observing parameters at various scales. To organize the indicators we present them using four scales of analysis – plot level, farm level, household level and the “landscape or administrative unit” scale (which could include community, watershed, a district, province or even nation). Focusing on only one scale can be useful for focused analyses but caution is necessary as ignoring lower or higher scales may result in missing tradeoffs not detected at the scale of interest. Also focusing on only one scale fails to consider important interactions across scales. Operationally indicators at lower scales will have to be aggregated up to higher levels so that relevant comparisons can be made. Aggregating up can be complicated where there is a diversity of conditions at the lower scales (such as soil types or typologies of farming households), which could make it inappropriate to sum or average at the community level or higher.

**3. How to use the SI indicator framework**

The SI indicator framework aims to be realistic for donor investment and practitioners’ needs by being adaptable to specific contexts and by providing a range of measures for any given indicator: from the gold standard to feasible proxies that are less resource demanding.

The following steps can be followed for using the SI indicator framework

1. Select indicators from each domain based on the specific technology or intervention being analyzed and the context where it is being promoted
2. Decide on how to measure each indicator based on the overall human and financial resources available for the exercise and the expected importance of each indicator in each context. The methods are listed in the right hand column of each table and are linked to the indicators in each row with superscript numbers.
3. Decide on how to operationalize each measure, including sample size and sampling strategy
4. Collect data
5. Analyze and communicate the results

Details on each of these steps will be developed soon.

**Productivity**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Concept | Field/plot (NPP) | Farm | Household | Landscape or Administrative Unit | Measurement method |
| Yield (partitioned by species and tissue type) and residues (total = NPP) | kg biomass (yield, fodder, residue, weeds) / ha / season 1,2,3  kg tree product (fruit, wood, fodder) / area under crown (or trees per ha) 1,2 | kg (yield, fodder, residue) / ha / season1,2,3 | Farmer perceptions and ratings of technology yield performance5 | Net Primary Productivity (above ground)4 | 1Agricultural survey (recall)  2Yield measurements  3Crop models (point models)  4Remote sensing (NPP of landscape)  5Farmer participatory trials, e.g., mother-baby trials |
| Fodder production considering quality | Crude protein production / ha 1,2,3  Metabolisable energy production / ha1,2,3 | Crude protein production / ha 1,2,3  Metabolisable energy production / ha 1,2,3 | N/A |  | 1Look up tables by species  2Near Infrared Spectroscopy  3Wet chemical testing |
| Animal productivity considering land area | Animal scale: Animal production by product (milk yield, weight gain, meat, manure, reproduction rate) 1,2 | Animal production by product (milk yield, weight gain, meat, manure) / ha grazing and fodder land used 1,2  Animal product/farm/year 1,2 |  | Net commercial off-take relative to the total grazing and fodder production area1 | 1Agricultural survey (recall)  2Production measurements |
| Variability of yield and animal productivity (over time and space) | Coefficient of variability, distribution, etc. of representative sample | Coefficient of variability, distribution, etc. of representative sample | N/A |  | Same as above but for several years |
| Livestock herd composition | N/A | Heifers per cow1  Calves per cow1  Oxen per TLU1 | TLU/ha of farm1 |  | 1Survey of farmers |
| Yield gap (use attainable yield or yield target) | Target – Actual (kg / ha / season) 1,2,3 | Target – Actual (kg / ha / season) 1,2,3 | Farmer perceptions of yield variation (discussion of why field yields vary, list of ranked causes)4 | Mean yield compared to maximum observed yield in similar location 1,2,3 | 1Field experiments  2Agricultural surveys  3Crop models  4Focus group - farmer participatory exercises |
| Cropping intensity (annual count) | Number of crops grown per year on a given plot (by crop)1  Plant population density (seeds/ha/season or seeds/ha year)2 |  | N/A | # crops grown per year across a landscape3  Plant population density of crops within a landscape1,3 | 1Agricultural Surveys  2Direct measurement of spacing in fields  3National and regional statistics. |

**Notes on productivity indicators:**

* The focus is on yield, partitioned by species and tissue type, in kg/ha/season and year. At a minimum, a better standard for measuring productivity is needed, especially for research projects, and may best be examined by partitioning among crops to have commodity specific measures of yield.
* The productivity of the land needs to be assessed in terms of all that is produced (not just grain yield), especially where fodder production is significant or where fruit trees are mixed into the landscape.
  + Biomass measures are often done once at harvest but some plants lose leaves through the growing season and these may rot before harvest.
* Comparisons of productivity across crops (e.g. cotton vs. maize) are difficult unless they are put into a common unit that is meaningful for farmer decision-making (such as local currency if both crops are sold). We need to look into the feasibility of using farmers’ subjective valuation of each crop to assign weights if a large portion of the crops are not sold.
* Farmer recall of harvest is pretty reliable but farmer estimates of area is not very accurate. Measuring is important.
* Fodder production amounts need to be adjusted based on the quality of the fodder. The simplest way to do this is to identify the most prevalent species and then look up their average nutritional quality as a fodder. A more robust method is to use Near Infrared Spectroscopy but this requires a clean vegetation sample (no soil) and it must be processed soon after sampling. It can be quite expensive.
* Animal productivity must be broken down into all the parts of the animal that are used (including manure). Estimating the land area used for grazing or fodder production is likely to be difficult or imprecise. Where draft power is the primary “product” then an assessment of the condition of the draft animals before, during and after their peak season of use may be needed.
* Net commercial off take = total sales of region – total purchase into region divided by region herd size
* Yield variability will be more easily interpreted as a percent of total production. It could also be used to estimate the probability of falling below food self-sufficiency or of achieving a production target (break-even point for a cash crop.
  + Variability across time and across space cannot be substituted
  + Detecting covariances in yields by crop can be helpful for evaluating how much diversification helps mitigate climate risk – one would expect sorghum and millet to vary together with rainfall
* Livestock composition is one way of observing if livestock production is intensifying. A herd with more cows is more commercial as the heifers and calves are more retained by those holding the herd for savings; below 4 TLU per ha can feed on farm
* Yield gap allows for comparison across agro-ecological zones by converting productivity information into the ratio of actual production to the highest observed production in similar conditions. There are limitations to inferences that can be made from this due to strong assumptions about the feasibility of reaching the highest yield.
* Cropping intensity is likely to be important to monitor where the intervention affects the likelihood of irrigation or planting during short season rains.
* Populations often vary across a single plot and this needs to be considered if sub-sampling for yields. It is difficult to interpret the reason for yield changes without knowing population density. This should especially be measured when extrapolating on yield from a few plants. Measuring can be done either as seeds planted and/or ideally as plant population density at harvest.
  + Detecting if thinning has been done can be informative about crop management – e.g in Mali do people thin sorghum?

**Economic**

| Concept | Field/plot | Farm | Household | Landscape or Administrative Unit | Measurement Method |
| --- | --- | --- | --- | --- | --- |
| Profitability | Profitability (output sold X price – input costs) 1,2 | Enterprise budget for livestock 1,2  Profitability for all crops 1,2 | Total agricultural profits per household 1,2 | Contribution to regional or national GDP 3,4 | 1 Agricultural survey  2 Household survey  3 Community survey  4 Regional and national statistics (secondary sources) |
| Variability of profitability | Combination of variability in production (Yield Risk, Livestock mortality) and variability in prices (Price volatility)1-4 | Probability that profits < threshold1-4 | Probability that profits < threshold1-4 | % hh in community with profits < critical level1-4 | 1Agricultural surveys  2Yield measurements  3Crop models  4Economic models |
| Income diversification | N/A | Diversification index for all marketable agricultural activities1 | Diversification index for all income activities1 |  | 1Household surveys |
| Input Use Efficiency (water, fertilizer, etc.) | kg output / unit input1,2 |  |  |  | 1Agricultural surveys  2Yield measurements |
| Limitations of land, labor and capital | Net returns per unit labor input, land input, capital input1,2 | Net returns per unit labor input, land input, capital input1,2 | % of total labor represented by the peak1,2,3  % of total expenses represented by the peak (Cash flow constraints)1,2,3 |  | 1Agricultural surveys  2Yield measurements  3Participatory assessments on adoption and scaling of interventions |
| Poverty rates (or estimates) | N/A | N/A | Assets, ability to mitigate losses from any one activity with another1 | Poverty head count1  Ag or rural wage/staple food price index1  Household expenditure1 | 1Household survey |
| Market participation | N/A | % of production sold (by crop, animal product)1 | % of total income from agriculture1 | % households selling an agricultural product1 | 1Household survey |
| Market orientation | N/A | % of land allocated to cash crops1 | % of total consumption from own production1 |  | 1Household survey |

**Notes on economic indicators**

* The focus is on profitability, variability of profitability and productivity of inputs that may be of critical importance in a particular context.
* Focus on profitability instead of gross agricultural income (cost/benefit analysis, per enterprise, crop etc.) as the former can be easily linked to poverty alleviation.
* Gross margins allows for a profitability analysis that excludes putting a value on household labor
* Variability in profitability is best measured directly through farmers’ actual production, input costs and output prices. However it is also feasible to estimate variability in profits using production variability and price volatility values. Assumptions would need to be made about when farmers sell if output prices vary seasonally (such as for maize in southern Africa).
* Thresholds and critical values for variability may relate to food security, poverty lines or similar objectives.
* Income diversification could simply be the number of sources of income or it could include the distribution of income across those sources, such as by using the Herfindahl index of concentration (see Ersado 2003 IFPRI paper on Zimbabwe), which is almost identical to the Simpson diversity index.
* Market orientation and Market participation:Market orientation measures the degree to which households produce for sale whereas market participation index measures the degree to which households participate in market as suppliers of their own produce. Bothmeasure the degree of commercialization**.** Commercialization is important to monitor for sustainable intensification because it can have direct links to food security, equity, nutrition and investment in further productivity. Furthermore in some contexts commercialization is a concern as it exposes farmers to price volatility risk. For more details on market orientation see Thom Jayne’s work on a commercialization index
* Returns to labor is related to income which can be linked to consumption and wellbeing.
* Input use efficiency: this is especially important to measure where a specific input is limiting (such as water in some contexts). However, in general it will be better not to over emphasize it but rather focus on output per unit of land (as is done in the productivity domain).
* Poverty rates at various scales have been suggested but may be difficult to measure as poverty is multidimensional. Some of the variables that may be included are: Food consumed at home, food purchases, in-kind food consumption, household demographics (hh size, age, gender), non-food purchases, ownership of durable and productive assets, housing construction, household rentals, asset rentals
* Aggregate to higher levels
* Bio-economic household modeling would be a great tool for looking at profitability, labor limitations, etc.

**Environment Part 1: Vegetation and water**

| Concept | Field/plot | Farm | Household | Landscape or Administrative Unit | Measurement method |
| --- | --- | --- | --- | --- | --- |
| Vegetative Cover | % bare ground (length of time per year)1, 5  % of living cover by month1,5  % cover of noxious (invasive) plants1,5  % tree cover1,5 | % vegetative cover and % tree cover (end of wet season, end of dry season, per year)1, 5  % of land burned (by month)2  Modeled cover from participatory research plot data6 | Farmer perceptions of vegetative cover4  Farmer participatory research on technologies cover5 | % vegetative and tree cover (end of wet season, end of dry season)1,3  % of animal feed coming from landscape (not farm)2  Spatial arrangement of feed sources in landscape3 | 1Quadrats or visual estimate of cover  2Agricultural survey  3Satellite images  4Focus group or survey documenting farmer perceptions  5Farmer participatory research trials  6Crop models |
| Plant Biodiversity | # species (agro-diversity and other diversity)1,2  Diversity Index1,2 | # species (agro-diversity and other diversity)1,2  Diversity index1,2 | N/A | % cover of natural habitat for rare species (conservation)3  % cover invasive species2,3 | 1Vegetation sample  2Transects  3Satellite images |
| Fuel | % residues used for fuel1,2  Wood production per ha (for agro-forestry systems)1,2 | % of manure used for fuel1,2  % of fuel produced that is sold1,2 | Average time spent obtaining fuel1,2  % of household fuel coming from farm 1,2 | Spatial arrangement of fuel availability3  % of fuel coming from off-farm landscape1-3 | 1Agricultural survey  2Household survey  3Participatory mapping |
| Water availability | # days during growing season without adequate soil moisture (from rain or irrigation) for crop growth1-3  # days with too much water (number of days waterlogged during critical crop growth)1-3 | Depth to shallow ground water4 | # months without adequate supply of clean drinking water (within 500m) 5  Farmer perceptions of water availability5 | % hh with year round access to drinking water5  % of livestock farmers with year round access to water2,5  % of irrigable land (given current investment) with sufficient irrigation water2  % of stream flow not diverted for agriculture or drinking water6 | 1Soil moisture measurements  2Agricultural survey  3Crop models  4Well monitoring  5Household survey  6Stream sampling |
| Water quality | Water salinity level1  NO3 level1  Zoonotics - #/ml1 | N/A | # of months without adequate supply of clean drinking water (within 500m) 2 | % of water sources (wells, streams) with clean water1.2  % of population with year round clean drinking water2 | 1Water sampling  2Household survey |

**Environment part 2: Soil and pollution**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Concept | Field/plot | Farm | Household | Landscape or Administrative Unit | Measurement method |
| Erosion | Estimate changes in components affecting soil loss:  C factor (crop type, tillage)1  P factor (practice to reduce erosion)1 |  | N/A | Erosion (t/ha/yr) (MUSLE or RUSLE)1  Sediment load in a watershed2 | 1Agricultural survey  2Stream sampling |
| Soil C | % C at each soil depth (labile C and total C)1  Total amount of soil C (bulk density \* percent)1  Carbon budget - Organic matter quantity and quality of inputs (to calculate C)2 |  | N/A |  | 1Soil tests (total C from combustion, labile C from permanganate oxidizable C test or C mineralization)  2Agricultural survey |
| Soil quality (health) | Index of soil properties1  Active soil C (mg/kg)1 | Farmer indigenous knowledge of soil (categories)2 | Farmer ranking of technology impact on soil quality3 |  | 1Soil tests and index of soil properties  2Survey or focus group to document farmer perceptions and knowledge  3Farmer participatory on-farm trials and action research |
| Soil acidity | pH 1  % Al saturation (if pH <5)1 | N/A | N/A |  | 1Soil tests |
| Soil salinity | EC (electrical conductivity)1 |  | N/A |  | 1Soil test |
| Nutrient Partial Balance | kg N,P, and K inputs (fertilizer, manure, etc.) less kg N, P, and K in total biomass removed (harvest, grazing) per hectare per year1,2 | kg N,P, and K inputs (fertilizer, manure, etc.) less kg N, P, and K in total biomass removed (harvest, grazing) per hectare per year1,2 | N/A | kg N,P, and K inputs (fertilizer, manure, etc.) – kg N, P, and K in total biomass removed (harvest, grazing) per hectare per year1,2 | 1Agricultural survey for inputs and outputs  2Lookup tables to estimate nutrients in harvest and organic inputs |
| GHG Emissions | CO2 equivalents per hectare (also broken down by CO2, CH4, and N2O)1 | CO2 equivalents per hectare (also broken down by CO2, CH4, and N2O)1 | N/A | CO2 equivalents per hectare (also broken down by CO2, CH4, and N2O)1 | 1Lookup tables for each activity or input |
| Pesticide use | Quantity applied per ha by type1 |  |  | Amount of pesticides in water supplies2 | 1Agricultural survey  2Water tests |

**Notes on environmental indicators**

* Each indicator is dependent on scale and time, and need to remain simple despite the potential losses in nuance in remaining simple. The indicators can be specified per context.
* Generally, the percent cover and percent tree cover are inclusive of each level despite needing slightly different metrics between farm and field. They are inclusive of both perennials and non-perennials. As scales increase, species diversity is of greater concern. There are two main indices of diversity: the Simpson index (which is more sensitive to changes in richness) and the Shannon index (which is a better measure of dominance in terms of abundance). Choosing between the two depends on the goals and context. Often both are reported.
* Nutrient balance can be particularly useful to avoid over application of nutrients and the environmental problems associated with it. It is less useful for diagnosing nutrient deficiencies. Phosphorous availability depends on soil type and organic inputs and its recycling is just as important as input and output balances. Nitrogen requires considering amount of biological nitrogen fixation by legumes. Potassium in most systems is adequately available through mineralization of parent material and its importance depends on the particular crop (such as bananas and tobacco).
* Erosion is often measured at landscape level but can be adapted for use at the plot level. Potential soil erosion loss is commonly assessed with the Universal Soil Loss Equation (USLE) as follows:
* A = R x K x LS x C x P With:
* **A** representing the potential long term average annual soil loss in tons per acre per year.
* **R** is the rainfall and runoff factor. The greater the intensity and duration of the rain storm, the higher the erosion potential.
* **K** is the soil erodibility factor. It is the average soil loss in tons/acre per unit area for a particular soil in cultivated, continuous fallow with an arbitrarily selected slope length of 72.6 ft. and slope steepness of 9%. K is a measure of the susceptibility of soil particles to detachment and transport by rainfall and runoff. Texture is the principal factor affecting K, but structure, organic matter and permeability also contribute.
* **LS** is the slope length-gradient factor. The LS factor represents a ratio of soil loss under given conditions to that at a site with the “standard” slope steepness of 9% and slope length of 72.6 feet. The steeper and longer the slope, the higher is the risk for erosion.
* **C** is the crop/vegetation and management factor. It is used to determine the relative effectiveness of soil and crop management systems in terms of preventing soil loss. The C factor is a ratio comparing the soil loss from land under a specific crop and management system to the corresponding loss from continuously fallow and tilled land. The C Factor can be determined by selecting the crop type and tillage method that corresponds to the field and then multiplying these factors.
* **P** is the support practice factor. It reflects the effects of practices that will reduce the amount and rate of the water runoff and thus reduce the amount of erosion. The P factor represents the ratio of soil loss by a support practice to that of straight-row farming up and down the slope. The most commonly used supporting cropland practices are cross slope cultivation, contour farming and strip cropping
* Soil quality can be difficult to measure directly. A feasible replacement for directly measuring soil C is to estimate the amount and quality of inputs.
  + Another proxy for soil fertility in some conditions is Fertilizer Responsiveness – low nutrient soils with low quality tend to be unresponsive
  + In some contexts specific weed species can be indicative of low or high soil fertility

**Social**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Concept | Field/plot | Farm | Household (hh) | Landscape or Administrative Unit | Measurement method |
| Equity (Gender, Marginalized group) – all indicators disaggregated by age, gender and ethnic background | N/A | % labor for power vs. control activities1-3  Rank drudgery (from 1 to 10)1-3  Ranking of technologies1-3  Rating of technologies across locally determined categories1-3 | Access to production factors (mechanization, land)1-4  Decision-making about production, marketing (by crop)1-4  Women Empowerment in Agriculture Index1 and 4 | Variability and distributions of productivity, income and assets1,4 | 1Individual survey  2Participatory evaluation  3Focus group discussions  4Household survey |
| Level of social cohesion | N/A | N/A | hh participation in community activities1,2  hh receiving help from within community, other community, government (bonding, bridging, linking)1,2  Level of integration of family activities1,2 | Active farmer groups3  Active innovation platforms3  % of community members participating in some form of social group1-3 | 1Household survey  2Focus group discussions  3Key informant interviews |
| Level of collective action | N/A | N/A | hh participation in a collective action group1 | # of collectively managed resource groups that are functioning beyond just existing to meet regulations2  # cooperative marketing groups2  # labor sharing groups and # days working together2  # problems addressed by innovation platforms2  Conflict resolution measures2  Capacity of these groups to organize (low staff turnover, transition plans)2  Number of cases of breaking rules2 | 1Household survey  2Key informant interviews |
| Conflicts over resources | N/A | N/A | Level of dissatisfaction with household decision-making1 | # of conflicts over resources 2,3  Presence of formal agreements for resource sharing 2,3 | 1Household interviews  2Focus group discussions  3Key informant interviews |

**Notes on Social Indicators:**

* Note from San Jose: The focus depends on the definitions of each indicator despite that the social indicators look at the impact of SI is for gender equality. For example, the goal is to evaluate if SI improves women’s access and use of resources in ways that improve their household and community decision-making power. However, evaluating such a relationship still requires definitions of terms such as equity. It may be important to finalize the social theory of change for SI to finalize indicators.
* The Women Empowerment in Agriculture Index survey process may be too demanding for many programs but we will be looking at how to select components from it that can be selected as needed.
* Access to production factors (such as plowing) can be measured indirectly (such as by when the fields controlled by that group get prepared as indicative of relative access to the plow).
* The social cohesion, collective action and conflict indicators need to be developed in terms of feasible metrics

**Human Condition**

| Concept | Field/plot | Farm | Household\* | Landscape or Administrative Unit | Measurement method |
| --- | --- | --- | --- | --- | --- |
| Nutrition | Diversity of crops grown (% of all land) disaggregated by consumption versus sale1  Protein production (kg/ha)1+2  Micronutrients in food produced (g/ha)1+2 | # of types of food available from own production1  Protein produced (kg/farm)1+2  Micronutrients in food produced (g/farm)1+2 | Dietary diversity (individual and household 24-hour recall)3,4  Food consumption score (7-day recall of frequency of food types)3  # of children not meeting minimum acceptable diet and minimum meal frequency4  Weight for age/height and height for age5  Uptake of essential nutrients (Zn, Fe, Vitamin A, Calcium)2+3 or 4  Modeled family nutrition (calories and protein/household-year) for different typologies1+8 | Rate of stunting (large scale development project only) and wasting (emergency response only)5  Average birthweight5  Market supply of diverse food6  Landscape supply of diverse foods (natural areas – not on-farm)7 | 1Agricultural survey  2Look up tables for nutrient values in food  3Individual survey  4Household survey  5Anthropometric measurements  6Survey of marketed foods  7Participatory mapping  8On-farm research to calibrate models, typologies from survey, linked to crop and farm models for predicting food security for range of environments/weather |
| Nutrition Awareness |  |  | # of members with adequate knowledge on breastfeeding, complementary feeding, Vitamin A, Iron, Iodine, and other essential nutrients1 | % hh with adequate nutrition knowledge1 | 1Individual survey |
| Food Safety | Pesticide application (#/ha and toxicity)1 |  | Food safety and toxicity (resulting from production, processing and storage)2  Aflatoxin contamination of key crops consumed by household (toxicity units per gram)2  Pesticide contamination3 |  | 1Agricultural survey  2Chemical testing  3Health center data |
| Food security | Food production (Calories/ha)1+2 | Potential food self-sufficiency (Calories/farm)1+2 | Months without food in hh3  Meals/day across seasons3  Food security index (various)3  Modeled food security (calories and protein/household-year) for different typologies1+5  Farmer perceptions (rating of food security)6 | Total food production1,3  Total food reserves3  Infrastructure (e.g. warehousing, access to markets/roads, irrigation; dependent on geography)4  Enabling trade policies4 | 1Agricultural survey  2Lookup tables for caloric values  3Household survey  4Key informant interviews  5On-farm research to calibrate models, typologies from survey, linked to crop and farm models for predicting food security for range of environments/weather  6Participatory farmer discussions |
| Capacity to experiment |  | # of new practices being tested by type (seed, management, etc.)1,2 | Literacy and numeracy of adults1,2 | Number of farmers experimenting1,2  % of men and women literate1,2  % of men and women with numeracy1,2 | 1Individual survey  2Focus group discussion |
| Human health |  |  |  | Infection rate of zoonotic diseases1  Prevalence of contaminated foods1 | 1Health center data |

\* Disaggregated by gender, age, ethnic background

**Notes on human condition indicators:**

* Note from San Jose: For the human domain, population level data is possible across households and communities, through census style survey. Farm-level data collection is possible if using the same collection tools towards the same measures and indicators. Basic assumptions: Availability of diverse foods 🡪 Equitable Access (at markets)🡪 Uptake of nutrients (level of disease and health e.g. suffering from worms or aflatoxins then can’t take in nutrients).
* For micronutrient production use look up tables of nutrient content based on kg crop produced
* Anthropometric measures are only suggested for large scale development projects with sufficient time and sample size to detect this
* Diet diversity surveys require careful training of enumerators to avoid introducing biases into the data.
* We have yet to fully explore all of the relevant food security index tools. For example, there is a FANTA tool for FS assessment, FAO also has one
* Farmer capacity is a recent addition to the framework and we have yet to explore the best ways to measure this

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